COAL IN CANADA

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A 100-ton truck is loaded with waste rock at the Balmer South Mine in eastern British Columbia.

Prepared for Energy Development Sector
by Information EMR

COAL
IN CANADA

Coal, the fuel that once heated our homes and powered our industries, is regaining its importance as an energy source after a major decline in the past two decades. In 1974, Canadian coal production reached a record 23.3 million tons, valued at $175 million. This surpassed the previous record of 19.1 million tons in 1950 and far outdistanced the low of 10.2 million tons produced in 1962. A continuing increase in production is expected because of the more extensive use of coal in Canada as an energy source and large export contracts with Japanese steel makers.

Employment in the industry, rather than declining, is steadily rising and, with the resurgence of coal mining, the spinoff effects in terms of goods and services supplied to the industry have been beneficial to many parts of the country. In 1972, the 39 operating coal mines in Canada employed about 7,000 persons.

Coal lost ground during the 1950's and 1960's because of the competition from oil and gas, but with shortages of energy now evident, coal is being, and will be, called on to meet increased requirements. As well, there are shortages from time to time of good quality metallurgical coal for use by the growing steel industry throughout the world. The overall shortage does not arise from a lack of coal, but from the inability of many countries to produce coal as cheaply as in the past.

A recent assessment of Canada's coal reserves indicates that about 95 per cent, or 118 billion tons, is located in western Canada. The remainder is found in the Maritimes. Reserves in the Yukon and the Arctic have not been evaluated. Canada has only 1.9 per cent of the world's coal reserves, but this amount can supply domestic needs and export sales for hundreds of years at present rates of consumption.

A 100-ton truck is loaded with coal by a large front-end loader at the Balmer South Mine in British Columbia.


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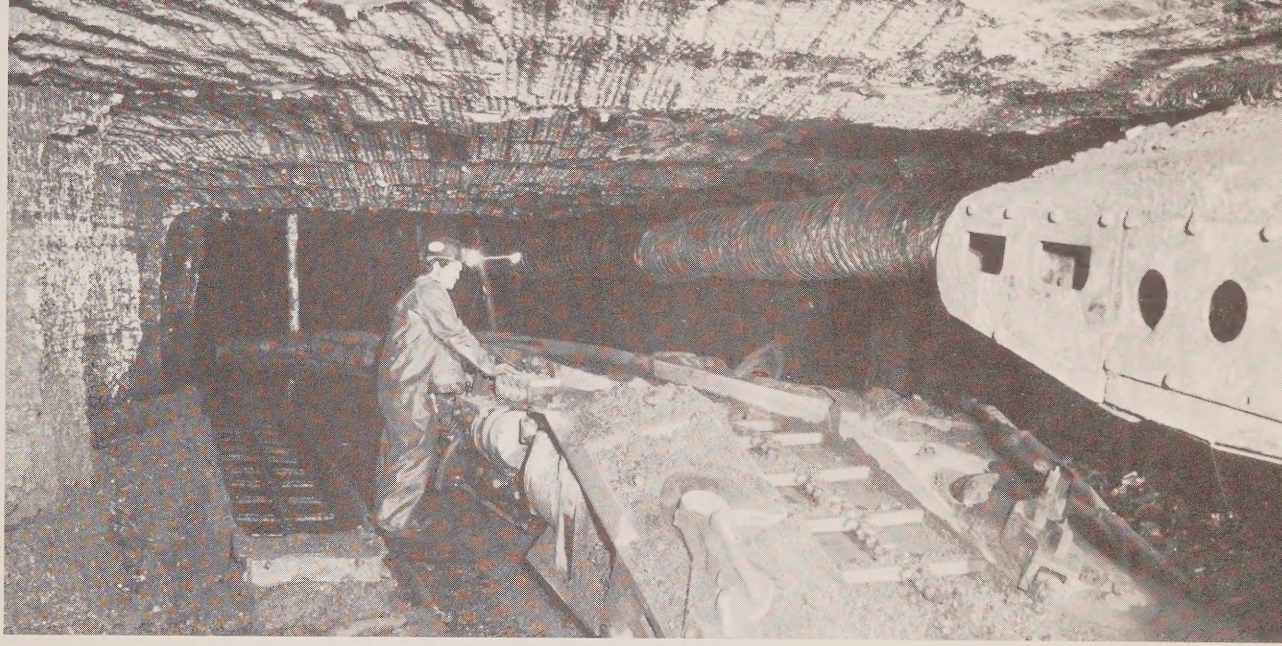
Alberta is currently Canada's largest producer of coal (9.2 million tons in 1974), followed by British Columbia (8.4 million tons) and Saskatchewan (3.8 million tons). In the same year, Nova Scotia produced almost 1.4 million tons and New Brunswick, 415,000 tons.

The United States and Russia, which each produce more than 500 million tons of coal a year, and China, which produces more than 300 million tons a year, are the world's largest coal producers. They also have the largest reserves. The United States has 32 per cent of global reserves; Russia, 26 per cent, and China, 22 per cent. Other major bituminous coal producers are Great Britain, Poland, Germany, India, South Africa and Australia.

Although Canadian coal production and reserves may be small compared to the world leaders, production costs are competitive with comparable mines elsewhere in the world. The prairie strip mines of Saskatchewan and Alberta are among the world's lowest in production costs. The surface mines in the mountain coal fields compare favorably with similar operations in other countries and costs of underground mining in western Canada are lower than all other countries except the United States, Australia



A miner operates the mechanical loader that picks up the surge pile of coal that has been mined by the continuous miner in the Lingan Mine in Cape Breton.

A large dragline removes the overburden to expose the coal seam at Whitewood Mine, Wabamum, Alberta.

and South Africa. Average productivity in Canadian mines in 1974 varied from 2.4 tons per man day in the underground mines of Cape Breton to 9.8 tons in British Columbia's underground mines, 50 in prairie surface mines and 20 in the Rocky Mountain surface mines.

Formation of Coal

Coal was formed in the setting of vast forests and swamps that covered large areas of the world at various times in the geological past. Most of Canada's coals were laid down during the Carboniferous period which began 280,000,000 years ago and lasted 50,000,000 years and the Cretaceous period which began 135,000,000 years ago and lasted 65,000,000 years. Most of the western Canadian coals developed during the latter period. These periods were characterized by warm humid climates favoring the growth of dense forests that grew, flourished and then decayed, forming thick layers of vegetable matter that gradually turned into deposits similar to modern peat bogs.

CLASSIFICATION OF COAL BY RANK

CLASS	DESCRIPTION	USE
Anthracite	"Hard coal" with a brilliant lustre. Burns slowly with blue flame. Contains 86 per cent to 98 per cent carbon and little moisture content.	Domestic fuel. Can be blended with bituminous coal to produce an improved coking quality.
Bituminous	Black usually banded coal. Most abundant variety. Little danger of spontaneous combustion if properly stored. Contains less than 86 per cent carbon. Moisture content higher than anthracite.	Domestic and industrial fuel. Medium to low-volatile coals used for producing coke for iron-ore smelting.
Subbituminous	Black coal. Contains 15 to 30 per cent moisture when mined. Is subject to spontaneous combustion.	Used primarily for thermal generation.
Lignite	Brown-to-black coal. Contains 30 to 40 per cent moisture. Disintegrates in air. Is liable to spontaneous combustion. Relatively low heat value.	Used in few areas for thermal generation.

Subsequent lowering of the land mass allowed the ancient seas to invade the bogs and cover them with beds of shale and sandstone. The increasing pressure of the overlying rocks further compressed the vegetable matter into beds of low-grade coal, such as lignite. With the passage of time and because of increasing heat and pressure, the buried deposits were further processed into higher grades of coal ranging upward in rank from subbituminous, to bituminous and finally to anthracite.

Coal increases in rank as the percentage of carbon in the coal increases and other elements are driven off. Coal consists of carbon hydrogen and oxygen with lesser quantities of nitrogen and sulphur. The geologically youngest coal, lignite, contains only 35 per cent carbon and more than 40 per cent water. The highest rank of coal, anthracite, contains up to 98 per cent carbon.

Coal is easily identified because of its color and texture and is readily observed in rock outcrops at the earth's surface. For that reason, coal was one of the first minerals found by the early explorers, trappers and missionaries. This was particularly true where coal was exposed in cliffs bordering the ocean or in the steeply uplifted sides of mountain valleys. Coal, however, was more difficult to find on the Prairies as there it is covered with a thick layer of sediments with few rock outcrops. Fortunately, some rivers have dug their channels through this overlying cover to expose coal seams, notably at Drumheller, Alberta. In many areas coal was discovered during well digging.

Coal Deposits in Canada

Canada possesses all ranks of coal except anthracite. Those of the Maritimes are bituminous, Saskatchewan's are lignite and the prairie region of Alberta holds subbituminous coal. The one deposit between the Maritimes and Saskatchewan at Onakawana, Ontario, near James Bay, is low-quality lignite, which may yet develop into a commercial useful energy source.

The Rocky Mountain fields in Alberta and British Columbia contain coals ranging from low to high-volatile bituminous and, in a few places, the coal has reached semi-anthracite rank. Prairie coals are generally geologically younger and are thus lower in rank.

The B.C. interior contains numerous but small deposits of bituminous and lignite coals. On Vancouver Island, the bituminous coal fields were extensively exploited during the last century and no commercial mining operations now exist. In the Yukon and Northwest Territories, there are many substantial deposits of bituminous and lignite coals. Although virtually unexploited, except for a small operation in the Yukon, the deposits may be of commercial importance in the future.

A driver checks his huge truck while waiting to be loaded at the Balmer open-pit mine in British Columbia.

Mining Methods

The days of the old miner using the hand pick and shovel are long gone. He has been replaced by the modern miner who is skilled in operating large, complex and expensive equipment that mechanically mines the coal. In a modern underground mine automated conveyor belts carry the coal to the surface while, in an open-pit mine, large 50 and 100-ton trucks carry the coal from the pit to preparation plants. Use of such machinery is an important reason why coal is an expanding industry and why Canada can now hope to rely on coal for much of its future energy needs.

Miners return to the surface from four miles under the sea at Number 26 Colliery in Cape Breton.

Surface Mining

When coal seams are relatively near the surface, the overlying soil and rock are stripped away, allowing the coal to be recovered in open pits using large earth-moving equipment. The profitability of this method depends largely on how much rock must be removed to uncover the seam compared with the thickness of the seam. This relationship is called the stripping ratio; for example, a ratio of 8:1 indicates that a coal seam 10 feet thick has an overburden of 80 feet.

The huge bucket of the dragline used in an open-pit mine near Sparwood, British Columbia.

◁ A shovel loads a truck with waste rock in the open-pit mine area in the Fernie coal basin, British Columbia.

Surface mining is employed in the Prairies, the Rockies and New Brunswick. Beneath the Prairies, coal seams lie relatively flat with a covering of poorly consolidated glacial deposits and bedrock that can easily be removed without expensive drilling and blasting. In the Rockies, coal occurs in more complex geological structures, following the contours of the mountains. Here, sloping coal seams are enclosed in strong rock beds. These rocks require blasting.

Underground Mining

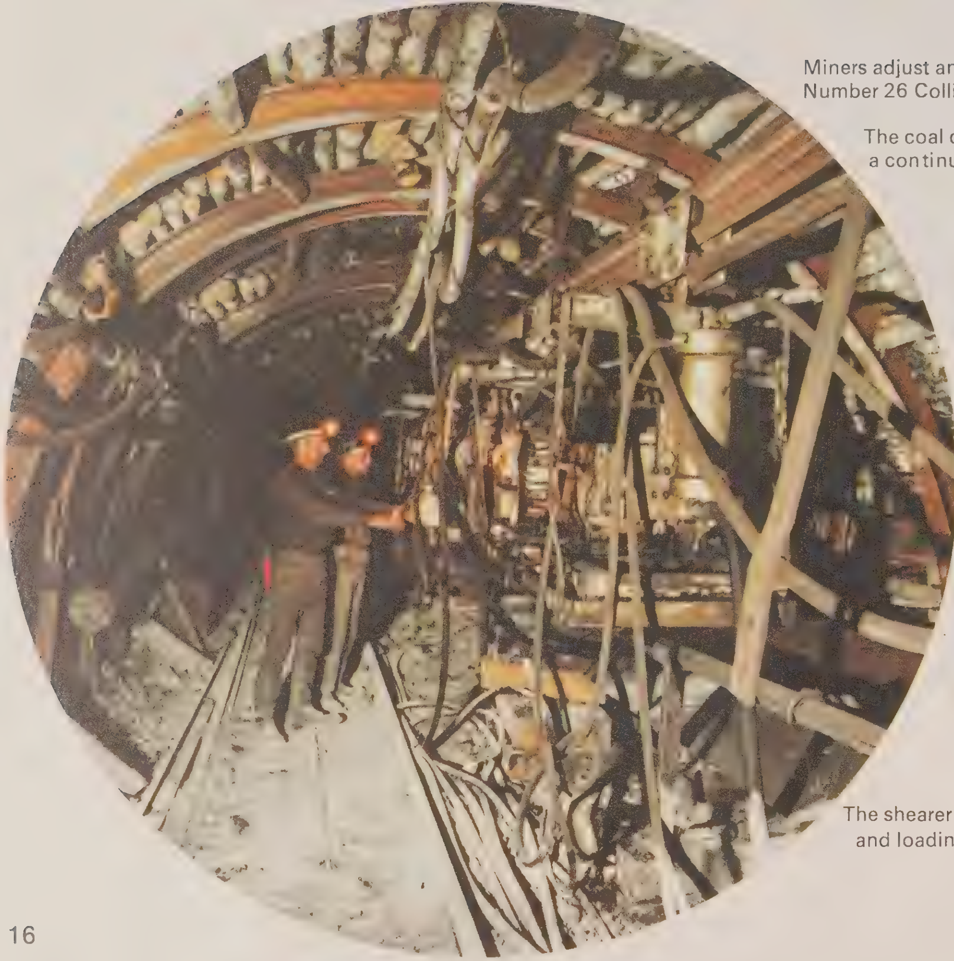
All of the mines in Nova Scotia and several mine operators in Alberta and British Columbia use the underground method because coal seams lie at much greater depths beneath the earth's surface. On Cape Breton the mines reach out under the Atlantic Ocean. Although mine entrances are near the coast, the actual mining takes place three to four miles from land at a depth of about 2,700 feet below the ocean bottom.

Two methods of mining underground coal are practised in Canada: the room-and-pillar method and the longwall method. The choice depends on geological conditions, safety and economics.

With the room-and-pillar technique, an area of coal in the mine is developed by driving rooms, leaving pillars of coal to support the overlying rock strata until the area has been completely opened up. Extraction of the pillars is then effected on the retreat in a controlled manner so that the roof collapses into the extracted zone. Depth, seam thickness and pitch all play a part in determining the relationship between room-and-pillar dimensions. In general, to be economical, the room-and-pillar method is restricted to mining depths of less than 1,500 feet.

Longwall mining was developed from the room-and-pillar system as a technique for extracting coal at greater depths than would be possible with room-and-pillar. Parallel roadways, about 600 feet apart are connected by the longwall face and the coal is extracted in slices over the length of the face. Special

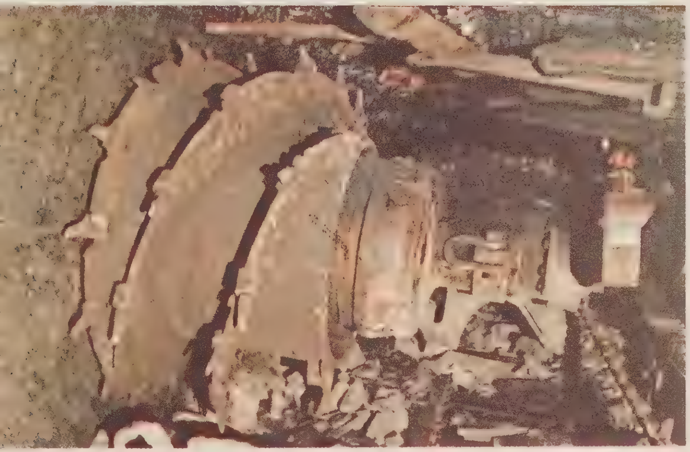
The head frame of Number 26 Colliery near Glace Bay, Nova Scotia. The wood stockpiled in the foreground is used as roof supports in the mine that extends out under the sea.



Miners adjust ancilliary longwall machinery in Number 26 Colliery in Cape Breton.

The coal cutting and loading section of a continuous miner used in the Lingan Mine in Cape Breton. ▷

The shearer used in longwall coal cutting and loading in Number 26 Colliery near Glace Bay, Nova Scotia. ▷



heavy mobile supports along the face form a protective tunnel and are moved forward as each slice of coal is extracted. The roof is allowed to collapse into the extracted void behind the face. Seams of up to 12 feet in thickness can be completely extracted by this method at depths reaching from 3,500 to 4,000 feet.

In the mountain region of British Columbia, a new system is being developed to extract all of a 50-foot-thick seam pitching at 40 degrees. A high pressure water jet cuts out the coal lying between two parallel roadways, 80 feet apart, previously driven in the seam. The return water then washes the extracted coal down special steel flumes to the surface at a point lower down the mountainside. This system is an adaptation of the room-and-pillar method.

The coal is brought to the surface and passed through a coal preparation plant. Here, impurities, such as sulphur and ash, are reduced, and the coal is screened, sized and dried to meet market requirements.

Transportation Methods

In some areas, getting the coal to market is relatively easy. On the Prairies, for example, there is often an electrical generating station nearby. In Cape Breton, the Sydney steel plant provides the major market for coal. But the British Columbia and Alberta mountain mines have a problem as most of their production is shipped to Japan, a market thousands of miles away. To reach the market, the coal is loaded onto specialized unit trains. Each mine has a specific number of unit trains assigned to it. The trains are made up of eighty-five 110-ton cars that can be loaded in three hours at the mine. The coal is hauled to modern bulk-handling terminals at Vancouver and dumped very quickly so that, in general, the cycle time for a train is around 72 hours. At the terminals, the coal may be stockpiled or loaded directly from the trains onto large capacity bulk carrier ships.

High transportation costs have always been a barrier to the use of Canadian coal in the highly industrialized regions of Ontario and Quebec so large quantities of coal are imported annually from United

A Japanese freighter loads at the Roberts Bank Bulk Loading Coal Terminal near Vancouver. Coal is stockpiled by the machinery in the background when no ship is ready for loading.

States mines, some of which are owned by Canadian steel companies. These mines are from 350 to 700 miles distant from the steel plants at Hamilton and Sault Ste. Marie, Ontario; the nearest Alberta mine is more than 1,400 miles away. Ontario Hydro also imports large quantities of coal from the United States which involves transportation distances of from 250 to 450 miles compared to from 1,400 to 1,900 miles for coal from Saskatchewan or Alberta.

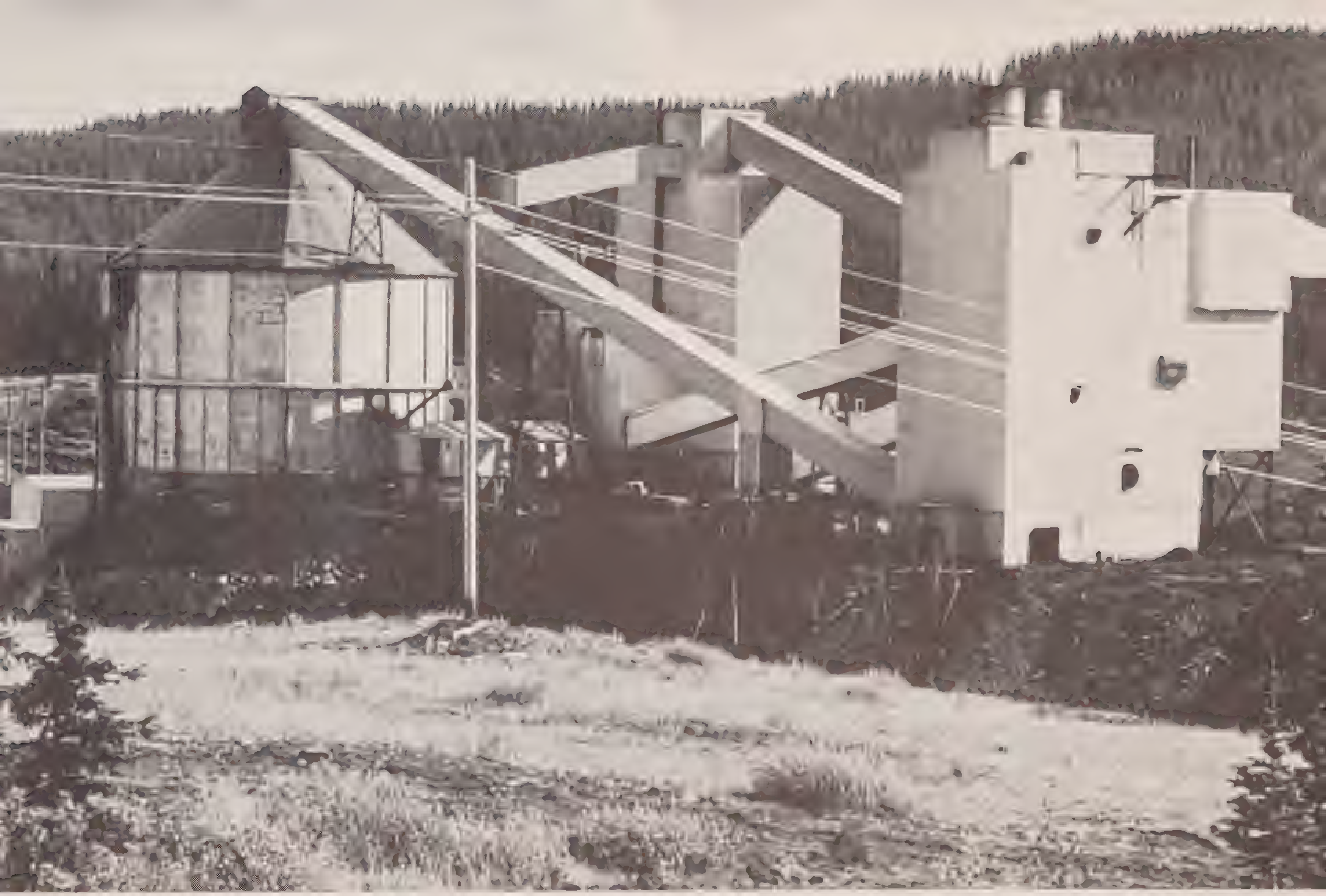
Although Canada produced 23.3 million tons of coal in 1974, we also imported 13.6 million tons. Of this amount, 13.2 million tons were of bituminous rank and 384,000 tons were anthracite. In the same year, Canada exported more than 11.6 million tons of coal, of which 10.9 million tons was to Japan alone.

A new transportation method for coal in use in some areas of the United States is the solids pipeline. The coal is crushed, mixed with water, then pumped through pipelines as a coal-in-water slurry. At the delivery end, perhaps hundreds of miles away, the water is removed and the recovered coal is ready for consumption. Because of the problems in the transportation of Canadian coal, Canada is investigating the solids pipeline and other new methods of transportation of coal.

Uses of Coal

Of the almost 39 million tons of coal consumed in 1974 by Canada, 17 million tons were used in thermal electric plants to produce electricity and more than 8.2 million to produce coke for the steel industry. In the late 1940's two of the principal uses of coal were for heating homes and powering railway locomotives. Today, these two markets are almost nonexistent.

The coal processing plant at the Cardinal River Coals Limited Mine in western Alberta.



When used in making steel, coal is converted into a carbonized form : coke. Coal is heated in batteries of coke ovens to temperatures high enough to drive off the natural volatile content, leaving a cinder-like substance composed mainly of carbon. This commodity has the desired physical strength and porosity required for its role in the steel-making process. Coke has two functions : to supply the heat required for the high-temperature operation of blast furnaces and to supply the carbon needed for the chemical reaction that reduces iron ore to liquid metallic iron.

High quality metallurgical coke can be made from only certain specific types of coal. Such coke must be low in ash and sulphur content and be of sufficient strength to withstand the load to which it is subjected in the blast furnace. Only certain premium coals of low and medium-volatile bituminous rank meet the requirements by themselves. However, of late a significant advance has been made in the technique of blending the premium coals with some of the marginal quality coking coals to yield a suitable metallurgical coke. In Canada all types of coking coals are located in British Columbia, the mountain belt of Alberta and the Sydney area, Nova Scotia.

It is possible to produce a large number of byproducts from coal, but this does not occur on any large scale in Canada as it is easier and cheaper to produce the same products from oil or natural gas. Currently, the production of byproducts from coal takes place at the steel-making plants. During the conversion to coke, the volatile elements are driven off and captured in forms ranging from combustible gases through oils of various grades down to tars. These are used to the extent found economical by the steel maker.

A likely future market requiring enormous annual tonnages of coal is the conversion of solid coal into liquid and gaseous fuels to supplement the world's relatively scarce supplies of conventional oil and natural gas. This process is of major importance to the United States but will probably not become a factor for Canada until later in the century. An important subsidiary benefit is that, during the conversion process, ash and sulphur contents are reduced, so the fuels produced can meet present regulations governing emissions from industrial smoke stacks.

The Environment

With all fuels there are problems in meeting legislation governing the pollution of our land, water and air. For coal, problems occur both at the point of production and at the point of consumption. At the mine site, the land may be disturbed and, during the preparation of the coal for market, there are also air and water pollution problems. At the points of consumption, such as thermal electric plants and steel works, there is the problem of air pollution.

Seedling trees are checked at the Kaiser Resources reclamation area at Sparwood, British Columbia. These seedlings will be transferred to an outdoor nursery and when large enough will be planted in the reclamation areas.

Grass partially covers a reclaimed area near Luscar, Alberta.

The coal industry is taking steps to reduce these effects on the environment. Following surface mining, the disturbed land is graded to approximately its original condition and the vegetation is restored. Extensive research is being done to find out what kinds of grasses, bushes, and trees can be planted with satisfactory results on these lands. Examples of this activity can be found in Alberta and British Columbia where there are strict environmental regulations governing strip mining.

At the plants of consumers, there has been considerable success in reducing the amount of fly ash discharged from the smoke stacks. The coal-burning plants of Ontario Hydro, for example, are extracting about 99.7 per cent of this ash. The trapping of noxious gases, such as sulphur dioxide, is more difficult but it is under active study in Canada and elsewhere. A current solution is to burn fuels with a naturally low sulphur content. As indicated earlier, another possible method of solving the problem is by the gasification of coal during which the natural content of ash and sulphur are reduced.

Federal Government Role

Over the past few years, the federal government has changed its form of assistance to the coal industry from one of providing direct financial aid in the form of subventions and low-cost loans to that of promoting research and development. This new approach, it is believed, holds greater promise for the long-term stability of the industry and ensures that maximum economic use will be made of our coal resources. Such federal action is conducted in consultation and cooperation with the governments of coal-producing provinces and with the industry.

The federal government is aware that escalating demands by the energy and metallurgical industries require that the best orderly use be made of all of Canada's coal, oil, gas, uranium and electricity resources. This means that there must be careful and detailed planning, on a long-term basis, by the federal and provincial governments and the industries that produce, transport and use these non-renewable resources. The government, through the Department of Energy, Mines and Resources, is therefore engaged in the formulation of policies and programs to make maximum economic use of all energy resources for the benefit of all Canadians.

The department's Energy Development Sector is responsible for developing policies with respect to Canada's coal resources. The sector assumed responsibility for coal when the Dominion Coal Board was dissolved in 1969. The sector, however, examines energy in all its forms—coal, oil, gas, uranium and conventional and nuclear-generated electric power—to ensure that national development policies are related in the most effective and economic way to Canadian needs. In coal energy, it initiates evaluations to determine the extent of Canadian coal reserves and their quality, provides assistance in the form of research and development grants to help improve the quality and utilization of coal, provides advice on production expansion rates compatible with profitability and projected demand in Canadian and foreign markets and undertakes studies on the interrelationship of the quality of coal, world price structures, transportation costs, interagency competition and environmental concerns.

The Mineral Development Sector of the department carries out studies on the mineral fuels, including the development of Canadian resources. The work covers all aspects of the mineral fuel industry from exploration, development, production, processing and transportation to consumption and trade. The results of this work are published from time to time and are used to advise other government departments and agencies on policy matters.

The Mines Branch of the department carries out applied and basic research to develop improved methods for extracting, processing, and utilizing coal and more than 60 other minerals mined in Canada.

With the resurgence of coal mining in western Canada, both new underground mines and surface stripping operations are rapidly being developed. At the Mines Branch particular attention is being given

Hydraulic mining is used in the Michel Colliery in British Columbia. This is a method where high pressure water cuts, breaks, and transports the coal.

A miner adjusts a roof support in the Michel Colliery in British Columbia. ▷

to the mountain coal deposits of Alberta and British Columbia where over 70 per cent of western coal is found, most of it locked in the thick, steeply dipping seams peculiar to the geology of the Rocky Mountains. Since only a fraction of the seams can be penetrated by current mechanized underground mining methods, most of this mountain coal is technically or economically unmineable today. Branch studies of underground mining practices, applied to similar seams in Poland, the USSR, and France, are revealing methods that might be adaptable to the Canadian scene.

The branch also focuses much attention on mine safety and the improvement of mine working conditions. The advent of bigger machines and deeper mines have produced an underground working environment polluted by dust, radiation, noise and diesel exhaust fumes. At its Ottawa and Elliot Lake mining research laboratories, it carries out tests on the sources, effects, and methods of controlling harmful components of mine air and develops improved measuring techniques.

At Ottawa, the branch recently completed a facility equipped to test the safety of diesel machinery for use in the explosive atmosphere of coal mines and to monitor the toxic constituents of engine exhaust. The results will help to determine adequate ventilation rates for underground workings.

Both current and future mining methods must be able to cope with hazards of gas outbursts and ground control problems. Some of the coal seams, because they are prone to outbursts, are not mined beyond 600 to 700 feet. Since much valuable coking coal is found beyond this depth, control and prevention of these outbursts would give access to significant western reserves. The branch has developed techniques for measuring the gases and the ignitability of these coals to determine conditions under which outbursts would occur.

Ground control problems involving the stability of the rock surrounding the mine openings limit both extraction ratios and productivity. Indeed, they have forced the closure of mines. In a continuing program of field trials, the branch is evaluating new artificial support systems and mining methods. The Mining Research Centre of the branch has long pioneered the

development of special instruments for monitoring rock movement and warning of dangerous conditions, and an increasing number of mining companies are adapting and using these techniques.

The branch has paid special attention to the upgrading of coking coals, coal testing, and the polluting effects of coal combustion in recent years. One branch program involves the evaluation of Alberta and British Columbia coking coals being developed industrially for the export market. A coke oven, installed at the Edmonton laboratory of the branch, is being used to determine the quality of coal on exploration properties and to quickly check coal blends from new mining operations when new areas are being opened up. The testing oven is expected to prove a boon to western coal producers ; it will be operated by the Mines Branch on a cost-sharing basis with the testing companies.

In eastern Canada, the high sulphur content of Cape Breton coal poses a particular problem. The branch has set under way a major investigation to determine the most economic method for desulphurizing Cape Breton coal at a pilot plant outside Sydney. The high sulphur content of the coal must be substantially reduced to meet local and export requirements as a coking coal for steel-making. Information gained through this program will determine the most suitable coal "cleaning" method for a full-scale local commercial plant, and it will also be applied to the treatment of sulphurous waste materials from Springhill, Nova Scotia, and New Brunswick mines.

The federal government's Mines Branch operates a coke-testing oven in this building located in Edmonton, Alberta.

To complement industrial research on fuel and mineral-related pollution, the Mines Branch has integrated its efforts in an environmental improvement program. The list of abatement projects indicates the emphasis placed by the branch on coal and oil pollution problems. Under current investigation are the removal of impurities from coal (and oil) prior to its combustion, neutralization of potential pollutants during combustion, more efficient combustion techniques, and more effective dispersion of the gaseous byproducts of combustion.

The Geological Survey of Canada, another branch of EMR, contributes to the improvement of Canada's coal situation in several ways.

The fundamental studies of the Survey, aimed at providing a comprehensive inventory and understanding of the geological framework of our country, indicate those broad geological regions in which coal deposits are likely to be found. This narrows down the search by prospectors and developers.

More specifically, regional studies help to assess the extent, position, and contents of coal seams in areas already known to contain the fuel. The "mineability" of coal seams is greatly influenced by their thickness, their inclination, the depth of overburden, the nature of the enclosing rock, presence of groundwater, etc. All of these are basically geological questions that require geological answers so that mining engineers can develop an efficient mining program for a particular seam or area. A knowledge of the geological framework of coal deposits determines the status of such deposits as national fuel reserves and facilitates comparison with other energy sources, their relative costs, availability, and conservation requirements. These are the factors that are required for investment decisions and for the formulation of government policy.

Other studies, carried out in the laboratory, concern the rank or type of coal and the microscopic structure of coal, which are of concern in assessing processability and combustion characteristics. Microscopic studies of spores and pollen grains tell us about the conditions under which the coal was formed and help us to identify coal seams.

Booklets on the activities of the Department of Energy, Mines and Resources are available free of charge. Write:

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